Reconnaissance Sensor Exploitation

Rome Research Corp N Y

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Final Technical Report
August 1976

RECONNAISSANCE SENSOR SYSTEM EXPLOITATION

Rome Research Corporation

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ROME AIR DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
GRIFFISS AIR FORCE BASE, NEW YORK 13441

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This report documents several tasks accomplished under the project titled "Reconnaissance Sensor System Exploitation". It is intended to give a brief summary of the sensor evaluations and analyses performed under the project along with Data Base and Northeast Test Area (NETA) support provided. Other efforts, considered to be of limited interest to the reconnaissance community, are not included in this report. Detailed information on any of the efforts completed during the contract may be obtained from Mr. A. Fanelli, RADC (IRRI), Griffiss AFB NY 13441.

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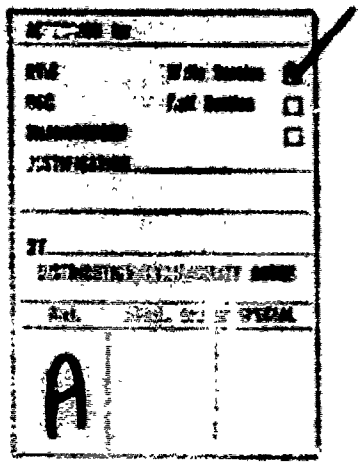

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EVALUATION

This final report documents the results of twelve months of Data Base operations, test area support for sensors, and sensor evaluation. This was accomplished by contractual personnel on-site at RADC and the Stockbridge Test Site.

The Data Base has been a valuable resource for imagery, technical documents and other intelligence information which could be drawn upon by both the military and industrial community.

Anthony R. Fanelli

ANTHONY R. FANELLI
Project Engineer

SECTION 1

INTRODUCTION

Documented in this report are the activities performed under Contract F30602-75-C-0172; it covers the period 2 May 1975 through June 1976. Three primary tasks are discussed in the report. These tasks are:

1.1. SENSOR EVALUATIONS

The basic objective of the sensor evaluation task was to determine the reconnaissance effectiveness of various sensor systems and to identify their performance characteristics. In addition, the use of different film/filter types to achieve optimum results was investigated.

Appraisal of system performance by trained, skilled image interpreters remains the least controversial and most effective means of evaluating sensor modifications and new applications.

1.2. DATA BASE OPERATIONS

Since its inception in 1965, the RADC/IRRE Reconnaissance Data Base has been a valuable resource for multisensor aerial imagery, technical documents, ground truth data, and other intelligence information to be drawn upon by members of the military and industrial reconnaissance community. It is unique in that it provides a readily available source of information to aid in solving reconnaisance problems concerning:

- Target Location and Identification
- Sensor-System Development
- Multisensor Interpretation and Analysis Techniques
- Digital Image Processing Techniques, and
- Image Processing and Reproduction Development.

Throughout the tenure of this contract, the Data Base has been in operation from 0800-1700 hours Monday through Friday.

1.3. NORTHEAST TEST AREA (NETA) SUPPORT

The Northeast Test Area comprises two elements:

1.3.1. Simulated NATO Tactical Targets

Three flight corridors and a designated boundary encompassing the Albany, NY area contain seventy-two NATO target analogs. Throughout the contract duration, target folders of these targets have been updated with current imagery examples (when available) and other ground truth data.

1.3.2. Military Equipment Display Area (MEDA)

The Military Equipment Display Area is located at the Stockbridge Test Site and consists of military units whose presence in the battlefield is identifiable based on the array of specific types of equipment in unique configurations. Each unit is tactically positioned as though on a battlefield, concealed when appropriate, and camouflaged when required. Maintenance of all equipment located in the MEDA, and ground truth documentation of the site, was accomplished throughout this program.

This report contains a description of the work performed under these tasks during the 13 months of the contractual effort.

SECTION 2

PROGRAM TASKS

2.1. TASK I - SENSOR EVALUATIONS

The evaluations accomplished during the period of this program varied in their objectives and scope. Brief summaries of each evaluation are presented to document the objective, evaluation method, and results. Detailed information on each evaluation can be obtained by contacting Mr. A. Fanelli, RADC/IRRE, Griffiss AFB, NY 13441.

2.1.1. Resolution Measurements

To indicate mission quality, a resolution analysis of selected imagery covering the Floyd resolution target was performed. Both line-of-flight (LOF) and cross-line-of-flight (XLOF) readings were taken. All data were recorded on a "Data Reduction Worksheet" (Table 1) that was designed at the onset of the program. Computation of resolution noted in cycles per millimeter was made on imagery collected during five missions by using the following formula:

$$R = \frac{(.00396)(h)}{(x)(f)}$$

where

R = Resolution (cycles/mm)
h = Height (AGL feet)
f = Focal length (inches)
x = Combined width of bar and space taken from the smallest resolved bar (feet)

Tables 2 and 3 are logs of the analyzed resolution of the Wild RC-8 Mapping Camera using both 2443 (Ektachrome I.R.) and 2402 (Plus-X Aerographic, ESTAR BASE) film types. Results of the analysis are as follows:

Mission	Film Type	Average Resolution LOF	Average Resolution XLOF
GR75-20	2402	6.68 cy/mm	18.03 cy/mm
GR75-23	2402	10.05 cy/mm	20.24 cy/mm
GR75-23	2443	18.56 cy/mm	15.87 cy/mm

These results are limited in usefulness because of:

(a) The small sample of imagery collected over the resolution target, and

(b) The fact that the location of the resolution target within the format changed, causing fall-off and resolution loss for certain readings.

Table 1 Data Reduction Worksheet

Mission No.__________ Date__________ Page_____of_____

	A		B		C	D	E	RESOLUTION
				Group	Bar			(c/mm)
Pass/Frame	(0.0396/f)	H	A x H	No.	Width	D = 2C	E = 1/D	B x E =

Table 2 Data Reduction Worksheet

MISSION NO. 7R75-C 2C DATE 29 APR. 75 PAGE 1 OF 1

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
0002 2402K12 LOF	.0066	18.53	12.21	4	1.17	2.34	4273504	5.22
0002 2402K12 XLOF	.0066	18.53	12.21	16	.43	.86	11627906	14.19
0020 2402K12 LOF	.0066	28.53	18.81	4	1.17	2.34	4273504	8.04
0026 2402K12 XLOF	.0066	28.53	18.81	16	.43	.86	11627906	21.87
LOF AVG 6.68								
XLOF AVG 18.03								

Table 3 Data Reduction Worksheet

MISSION NO. GR75-023 DATE 7 MAY 75 PAGE 1 OF 1

PASS/FRAME	A (0.0396/F)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
2443 K-12 60F	.00666	5625	37.125	5	1.00	2.00	.5	18.56
2443 K-12 .6 60F	.00666	5625	37.125	4	.17	2.34	.427350	15.87
2402 15-12 0410 60F	.00666	2300	15.18	6	.182	1.64	.609756	9.26
2402 K-12 0410 60F	.00666	2300	15.18	9	.5	1.0	1.0	15.18
2402 K-12 0417	.00666	2300	15.18	7	.7	1.4	.714285	10.84
2402 K-12 0417	.00666	2300	15.18	12	.3	.60	1.666666	25.30
	2402 60F AVG. 10.05							
	4 60F AVG 20.24							

The majority of resolution measurements were made on the KS-87 CPA and KS-87 Non-CPA film which will be discussed under the sub-section titled Comparative Evaluation of KS-87 Non-CPA And KS-87 CPA Imagery.

2.1.2. Comparative Evaluation Of KS-87 Non-CPA And KS-87 CPA Imagery:

The object of this evaluation was to determine the value of the application of the CPA (Concurrent Photon Amplification) technique to aerial reconnaissance photography. Concurrent Photon Amplification (CPA) is a technique that was developed to expand the amount of perceptible detail on an image when low-level lighting conditions exist. The CPA technique provides an overall uniform non-imaging exposure simultaneously with the imaging exposure. This effectively increases the film speed of a particular photographic emulsion by capturing electrons to form silver atoms, some of which in turn will tend to increase the size of the pre-image and sub-image specks formed by the imaging exposure, and thus raise them to a level at which they can be developed.

The KS-87B camera was modified with CPA equipment developed by C and C Research, Inc. Two cameras were so equipped, one with a 6" focal length lens and the other with a 10" focal length lens. These cameras were employed to obtain coverage of targets at the Floyd and Stockbridge Test Sites.

Kodak 2402 Black and White film was used for the major portion of flight testing. Twelve attempts at imagery acquisition were accomplished with this film. Eleven missions were successful. A camera malfunction occurred on the first mission flown. Table 4 depicts the missions flown for this evaluation.

The evaluation was conducted in three phases. The first phase was a resolution analysis and a comparison of the CPA and Non-CPA photography. Resolution was measured on photography collected simultaneously by both cameras mounted in an RADC Flight Test Division C-131 aircraft. A diagram of the resolution target located at the Floyd site and used for this evaluation is depicted in Figure 1; bar widths are given in Table 5. Tables 6 through 11 are logs of the analyzed resolution on both CPA and Non-CPA cameras. It was found that the average XLOF resolution of imagery acquired by the CPA camera (vs. Non-CPA) was greater on 5 out of 6 missions flown. LOF resolution of imagery was greater for the CPA on 3 out of 6 missions flown, and the same for both on one mission (GR75-005). On 2 missions, GR75-013 and GR75-017, the LOF resolution was greater on imagery collected by the Non-CPA camera.

Phase II of this study consisted of a subjective evaluation of imagery collected simultaneously over the Military Equipment Display Area (MEDA) at the Stockbridge Test Site. The imagery was viewed by two experienced image interpreters employing all target identification techniques. As a result it was determined that the CPA-enhanced imagery exhibited increased interpretability over the normally exposed imagery (Figure 2). Sensitometric tests have indicated that an increase in image speed has been limited to lower densities. Thus the CPA technique seems to have potential advantages in light conditions where shutter speeds are a limiting factor.

TABLE 4

Missions Flown For CPA/Non-CPA Evaluations

Mission-Number	Date-Flown	Film Type
GR 75-002*	7 Jan 75	2402
GR 75-004	9 Jan 75	2402
GR 75-005	30 Jan 75	2402
GR 75-011	11 Mar 75	2402
GR 75-012	13 Mar 75	2402
GR 75-013	17 Mar 75	2402
GR 75-015	10 Apr 75	2402
GR 75-016	14 Apr 75	2402
GR 75-017	15 Apr 75	2445
GR 75-021	5 May 75	2445
GR 75-024	8 May 75	2402
GR 75-027	15 May 75	2402
GR 75-028	20 May 75	2402
GR 75-038	11 Jun 75	2424

* Camera Malfunction

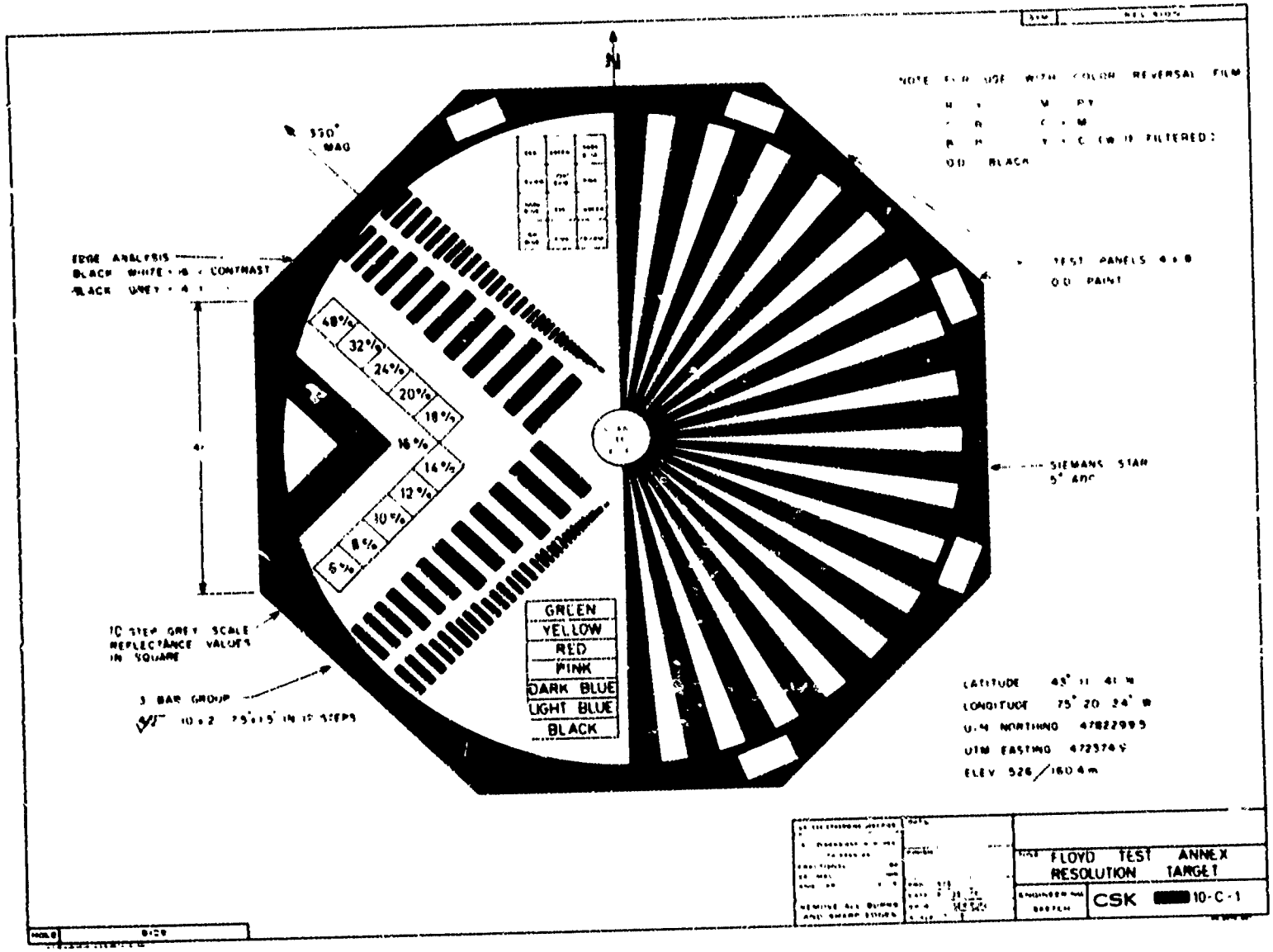


Figure 1 Diagram of Resolution Target

FLOYD ENGINEERING TARGET

LARGEST BAR WIDTH = 2.00'

2 INCREMENT = 1.189207

1/1.189207 = .8408964

BAR GP #	BAR WIDTH	2X BAR WIDTH
1	2.00	4.00
2	1.7	3.4
3	1.41	2.82
4	1.17	2.34
5	1.00	2.00
6	.82	1.64
7	.7	1.4
8	.6	1.2
9	.5	1.00
10	.43	.86
11	.35	.70
12	.3	.60
13	.25	.50
14	.21	.42
15	.17	.34
16	.15	.30
17	.125	.25

Table 5 Floyd Engineering Target

Table 6 Data Reduction Worksheet

MISSION NO. GR 75-005 NON-CPA DATE 30 JAN 75 PAGE 1 OF 2

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
1 LOF	.0066	1851	12.2166	9	.5	1.0	1.162790698	12.21
XLOF		1851	12.2166	10	.43	.86	1.162790698	14.20
2 LOF		1818	12	9	.5	1.0	1.162790698	8.57
XLOF		1818	12	10	.43	.86	1	13.95
3 LOF		1818	12	9	.5	1.0	1.162790698	12
XLOF		1818	12	10	.43	.86	1.162790698	13.95
4 LOF		1818	12	10	.43	.86	1.162790698	13.95
XLOF		1818	12	10	.43	.86	1	12.95
5 LOF		1851	12.2166	9	.5	1.0	1.162790698	14.21
XLOF		1851	12.2166	10	.43	.86	1	12
6 LOF		1818	12	9	.5	1.0	1	12
XLOF		1818	12	10	.43	86	1.162790698	13.95
7 LOF		1818	12	9	.5	1.0	1	12
XLOF		1818	12	10	43	.86	1.162790698	13.95
8 LOF		1255	11.28	10	.43	.86	1.162790698	13.20
XLOF		1285	11.28	11	.35	70	1.428571429	16.82
9 LOF		1818	12	10	43	.86	1.162790698	13.95
XLOF		1818	12	11	.35	70	1.428571429	12.14
10 LOF		1818	12	9	5	1.0	1	12
XLOF	↓	1818	12	10	43	.86	1.162790698	13.95
			LOF		XLOF			
	NON CPA		12.26		14.61			

Table 6 Data Reduction Worksheet (Continued)

MISSION NO. GR75-002 CPA DATE 30 JAN 75 PAGE 2 OF 2

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
1 LOF	.0066	1785	11.78	9	.5	1.0	1	11.78
XLOF		1785	11.78	11	.55	.70	1.42857142	16.83
2 LOF		1818	12	10	.43	.86	1.16279069	13.95
XLOF		1818	12	13	.25	.50	2	24
3 LOF		1818	12	9	.5	1.0	1	12
XLOF		1818	12	12	.3	.60	1.66666667	20
4 LOF		1851	12.21660	9	.5	1.0	1	12.22
XLOF		1851	12.21660	10	.43	.86	1.16279069	14.30
5 LOF		1818	12	9	.5	1.0	1	12
YLOF		1818	12	9	.5	1.0	1	12
6 LOF		1818	12	9	.5	1.0	1	12
XLOF		1818	12	10	.43	.83	1.16279069	13.95
7 LOF		1851	12.21660	9	.5	1.0	1	12.22
XLOF		1851	12.21660	9	.5	1.0	1	12.22
8 LOF		1851	12.21660	9	.5	1.0	1	12.22
XLOF		1851	12.21660	9	.5	1.0	1	12.22
9 LOF		1818	12	9	.5	1.0	1	12
XLOF		1818	12	9	.5	1.0	1	12
10 LOF		1851	12.21660	9	.5	1.0	1	12.22
XLOF	▼	1851	12.21660	9	.5	1.0	1	12.22
			LOF		XLOF			
	CPA		12.26		16.16			

Table 7 Data Reduction Worksheet

MISSION NO. GR75-015 DATE 10APR75 PAGE 1 OF 1

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
CPA 13 LOF	.00616	10,000	616	3	1.41	2.82	.3546099	23.40
XLOF		10,000	616	3	1.41	2.82	.3546099	23.40
18 LOF		10,000	616	4	1.17	2.34	.4273504	28.21
XLOF		10,000	616	4	1.17	2.34	.4273504	28.21
39 LOF		5000	33	7	.82	1.64	.625	20.63
XLOF		5000	33	6	.82	1.64	.625	20.63
4% LOF		5000	33	6	.82	1.64	.625	20.63
XLOF		5000	33	7	.7	1.4	.7142857	23.57
18% LOF		2500	16.5	9	.5	1.0	1.0	16.5
XLOF		2500	16.5	11	.35	.70	1.4285714	23.57
18% LOF		2500	16.5	9	.5	1.0	1.0	16.5
XLOF		2500	16.5	11	.35	.70	1.4285714	23.57
19% LOF		1500	9.9	15	.17	.34	2.9411764	29.12
XLOF		1500	9.9	14	.21	.42	2.3809523	23.57
				LOF	XLOF			
			CPA	22.14	23.78			
NON CPA 13 LOF		10,000	616	3	1.41	2.82	.3546099	23.40
XLOF		10,000	616	4	1.17	2.34	.4273504	28.21
18% LOF		10,000	616	5	1.00	2.00	.5	33.0
XLOF		10,000	616	4	1.17	2.34	.4273504	28.21
39 LOF		5000	33	6	.82	1.64	.625	20.63
XLOF		5000	33	7	.7	1.4	.7142857	23.52
4% LOF		5000	33	6	.82	1.64	.625	20.63
XLOF		5000	33	8	.6	1.2	.8333333	27.50
18% LOF		2500	16.5	9	.5	1.0	1.0	16.5
XLOF		2500	16.5	10	.43	.86	1.1627906	19.19
18% LOF		2500	16.5	8	.6	1.2	.8333333	13.75
XLOF		2500	16.5	9	.5	1.0	1.0	16.5
19% LOF		1500	9.9	16	.15	.30	3.3333333	33
XLOF		1500	9.9	16	.15	.30	3.3333333	33
				LOF	XLOF			
			NON CPA	22.09	25.17			

Table 8 Data Reduction Worksheet

MISSION NO. GR75-16 DATE 14 April 75 PAGE 1 OF 3

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
CPA								
1983 LOF	.0066	10,000	66	4	.117	2.34	.4273504	28.21
XLOF		10,000	66	5	1.0	2.0	.5	16.5
1986 LOF		9,500	62.7	4	.117	2.34	.4273504	26.79
XLOF		9,500	62.7	3	.141	2.82	.3546099	22.23
1991 LOF		4750	31.35	5	1.0	2.0	.5	15.68
XLOF		4,750	21.35	6	.82	1.64	.609756	19.12
1998 LOF		4750	21.35	6	.82	1.64	.609756	19.12
XLOF		4750	31.35	7	.7	1.4	.7142857	22.35
2015 LOF		2925	19.305	8	.6	1.2	.8333333	15.87
XLOF		2925	19.305	7	.5	1.0	1.0	19.305
2038 LOF		2700	17.82	8	.6	1.2	.8333333	14.85
XLOF		2700	17.82	9	.5	1.0	1.0	17.82
2074 LOF		1575	10.395	12	.3	.6	1.6666666	17.32
XLOF		1575	10.395	12	.3	.6	1.6666666	17.33
2102 LOF		1575	10.395	10	.43	.86	1.1627906	12.08
XLOF	↓	1575	10.395	11	.35	.7	1.4285714	14.84
			LOF		XLOF			
	CPA		18.74		18.69			

Table 8 Data Reduction Worksheet (Continued)

MISSION NO. GR75-16 DATE 14 April 75 PAGE 2 OF 22

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
Non CPA								
8622 LOF	.0066	10,000	66	1	2.00	4.00	.25	16.5
x LOF		10,000	66	3	1.41	2.82	.3546099	23.40
8627 LOF		9500	62.7	1	2.00	4.00	.25	15.68
x LOF		9,500	62.7	0				0
8633 LOF		4750	31.35	3	1.41	2.82	.3546099	11.12
x LOF		4750	31.35	5	1.0	2.0	.5	15.68
8640 LOF		4750	31.35	4	1.17	2.34	.4273504	13.40
x LOF		4750	31.35	4	1.17	2.34	.4273504	13.40
8658 LOF		2925	19.305	8	.6	1.2	.83333333	16.09
x LOF		2925	19.305	8	.6	1.2	.83333333	16.09
8682 LOF		2700	17.82	7	.7	1.4	.7142857	12.73
x LOF		2700	17.82	9	.5	1.0	1.0	17.82
8721 LOF		1575	10.395	11	.35	.7	1.4285714	14.85
x LOF		1575	10.395	10	.49	.98	1.0204082	10.60
8749 LOF		1575	10.395	10	.43	.86	1.1627906	12.09
x LOF	↓	1575	10.395	10	.43	.86	1.1627906	12.09
			LOF		x LOF			
	Non CPA		14.06		13.82			

Table 9 Data Reduction Worksheet

MISSION NO. GR75-017 DATE 15 Apr 25 PAGE 1 OF 1

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
9 (2445 CM) LOF	.0066	10,000	66	3	1.41	2.82	.3546099	23.40
X LOF		10,000	66	4	1.17	2.34	.4273504	28.21
12 LOF		9,500	62.7	3	1.41	2.82	.3546099	22.23
X LOF		9500	62.7	3	1.41	2.82	.3546099	22.23
45 LOF		5050	33	6	.82	1.64	.625	20.63
X LOF		5000	33	6	.82	1.64	.625	20.63
49 LOF		4950	32.67	6	.82	1.64	.625	20.42
X LOF		4950	32.67	7	.7	1.4	.7142857	23.34
233 LOF		2500	16.5	9	.5	1.0	1.0	16.5
X LOF		2500	16.5	10	.43	.86	1.1627906	19.18
241 LOF		2475	16.335	10	.43	.86	1.1627906	19.00
X LOF		2475	16.335	9	.5	1.0	1.0	16.34
253 LOF		1500	99	13	.25	.50	2	19.8
X LOF		1500	99	14	.21	.43	2.3809523	23.57
			LOF	X LOF				
			16.93	21.92				
9 (2445 CM) LOF		10,000	66	3	1.41	2.82	.3546099	23.40
X LOF		10,000	66	3	1.41	2.82	.3546099	23.40
12 LOF		9500	62.7	3	1.41	2.82	.3546099	22.23
X LOF		9500	62.7	3	1.41	2.82	3546099	22.23
43 LOF		5000	33	7	.7	1.4	.714-2857	23.57
X LOF		5000	33	6	.82	1.64	.625	20.63
48 LOF		4950	32.67	7	.7	1.4	.7142857	23.34
X LOF		4950	32.67	8	.6	1.2	.83333333	27.22
232 LOF		2500	16.5	9	.5	1.0	1.0	16.5
X LOF		2500	16.5	9	.5	1.0	1.0	16.5
240 LOF		2475	16.335	9	.5	1.0	1.0	16.34
X LOF		2475	16.335	10	.43	.86	1.1627906	19.00
257 LOF		1500	99	12	.3	.6	1.66666666	16.50
X LOF	V	1500	99	13	.25	.50	2	19.8
				20.27	X LOF			
					21.25			

Table 10 Data Reduction Worksheet

MISSION NO. GR75-24 DATE 8MAY75 PAGE 1 OF 2

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
FLOYD #8(PM) LOF	.0396	1500	9.9	10	.43	.86	1.1627906	11.51
XLOF		1500	9.9	10	.43	.86	1.1627906	11.51
FLOYD #7 LOF		1500	9.9	12	.3	.6	1.6666666666	16.50
XLOF		1500	9.9	14	.21	.42	2.3809523	23.57
FLOYD #2 [illegible]								
FLOYD #1 LOF		1500	9.9	10	.43	.86	1.1627906	11.51
XLOF		1500	9.9	11	.35	.35	2.8571428	28.29
FLOYD #3 LOF		10000	66	3	1.41	2.82	.3546099	23.4
XLOF		10000	66	3	1.41	2.82	.3546099	23.4
FLOYD #4 LOF		10000	66	3	1.41	2.82	.3546099	23.4
XLOF		10000	66	3	1.41	2.82	.3546099	23.4
FLOYD #5 LOF		10000	66	3	1.41	2.82	.3546099	23.4
XLOF		10000	66	4	1.17	2.34	.4273504	28.21
FLOYD #6 LOF		10000	66	2	1.7	3.4	.2941176	19.41
XLOF	↓	10000	66	3	1.41	2.82	.3546099	23.40
			60F	23.0				
		CPA	18.45	23.11				

Table 10 Data Reduction Worksheet (Continued)

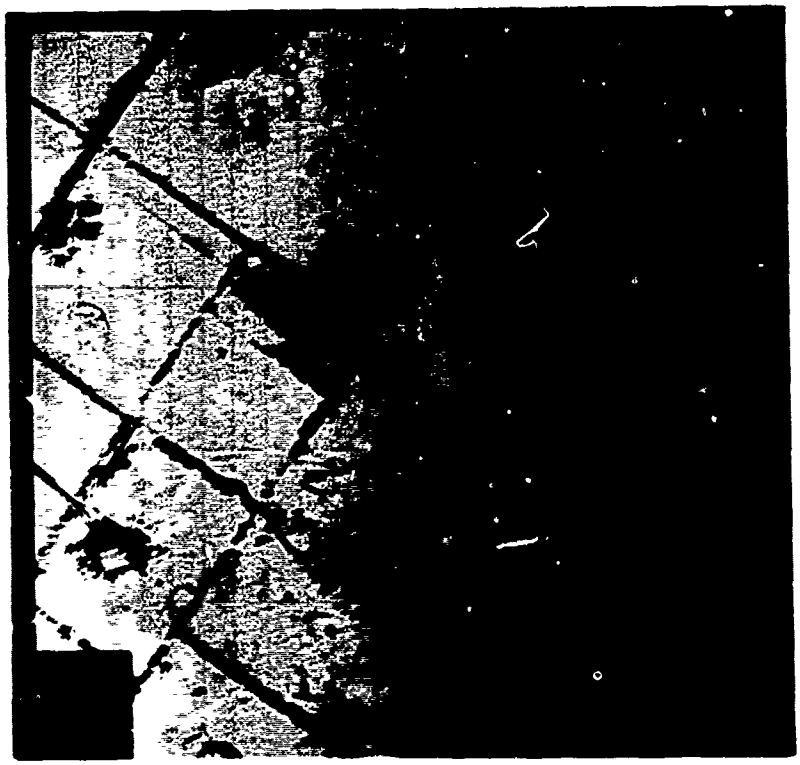
MISSION NO. GR75-24 DATE 8 MAY 75 PAGE 2 OF 2

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
NON CPA								
FLOYD #8 ⊥OF	.0396	1500	99	7	.7	1.4	.7142857	7.07
XLOF		1500	99	6	.6	1.2	.8333333	8.25
FLOYD #7 ⊥OF		1500	99	9	.5	1.00	1.00	9.5
XLOF		1500	99	8	.6	1.2	.8333333	8.25
FLOYD #2 CAMERA MALFUNCTION								
FLOYD #1 ⊥OF		15000	66	12	.5	.6	1.6666666	16.50
XLOF		15000	66	10	.43	.86	1.1627906	11.51
FLOYD #3 ⊥OF		10000	66	1	2.00	4.00	.25	16.5
XLOF		10000	66	1	2.00	4.00	.25	16.5
FLOYD #4 ⊥OF		10000	66	0	—	—	—	0
XLOF		10000	66	0	—	—	—	0
FLOYD #5 ⊥OF		10000	66	0	—	—	—	0
XLOF		10000	66	0	—	—	—	0
FLOYD #6 ⊥OF		10000	66	0	—	—	—	0
XLOF	↓	10000	66	0	—	—	—	0
							—	0
				⊥OF	XLOF			
		NON CPA		12.49	11.13			

Table 11 Data Peduction Worksheet

MISSION NO. [illegible] DATE [illegible] PAGE 1 OF 1

PASS/FRAME	A (0.0396/f)	H	B A x H	GROUP NO.	C BAR WIDTH	D D = 2C	E E = 1/D	RESOLUTION (c/mm) B x E =
NOR CPA								
#2 COF	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.5
XCOF		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27.5
#3 COF		[illegible]	7.92	[illegible]	[illegible]	[illegible]	[illegible]	18.86
XCOF		[illegible]	7.92	13	17	.34	2.941176470	23.27
#4 COF		[illegible]	7.92	13	20	.32	2.0	15.84
XCOF		[illegible]	7.92	14	.21	.42	2.380952381	18.96
#5 COF		[illegible]	8.25	14	.21	.42	2.380952381	19.04
XCOF		[illegible]	8.25	13	.17	.34	2.941176470	24.26
#6 COF		[illegible]	8.25	13	.25	.50	2.0	16.50
XCOF		[illegible]	8.25	14	.21	.42	2.380952381	19.04
#7 COF		[illegible]	3.9404	7	.7	1.4	.714285714	24.96
XCOF		[illegible]	3.9404	8	.6	1.2	.833333333	27.12
				COF	XCOF			
		NOR	CPA	20.25	23.25			
CPA								
#2 COF		[illegible]	33	7	.7	1.4	.714285714	23.51
XCOF		[illegible]	33	8	.6	1.2	.833333333	27.5
#3 COF		[illegible]	7.92	13	.25	.50	2.0	15.84
XCOF		[illegible]	7.92	12	.3	.6	1.666666666	13.2
#4 COF		[illegible]	7.92	13	.25	.50	2.0	15.84
XCOF		[illegible]	7.92	12	.3	.6	1.666666666	13.2
#5 COF		[illegible]	8.25	9	.5	1.0	1.0	8.25
XCOF		[illegible]	8.25	9	.5	1.0	1.0	8.25
#6 COF		[illegible]	8.25	10	.43	.86	1.162790697	9.59
XCOF		[illegible]	8.25	7	.5	1.0	1.0	8.25
#7 COF		[illegible]	3.9404	4	1.17	2.34	.427350427	14.93
XCOF		0.5868	3.9404	4	1.17	2.34	.427350427	14.93
				COF	XCOF			
			CPA	14.62	17.22			



non CPA

CPA

Figure 2 CPA/Non-CPA Examples

The objective of Phase III of this study was to determine the effectiveness of the CPA equipped KS-87B camera. To accomplish this, an interpretation test was designed and administered to 16 trained image interpreters.

Ten different target scenes were selected for the test. Five scenes were imaged with the KS-87 CPA camera, and five scenes with the KS-87 Non-CPA camera. The interpreters were not made aware of the type of imagery they were viewing (CPA or Non-CPA). Seven interpretation exercises were completed. Table 12 summarizes the results of interpreter testing. As can be derived from these data, the CPA imagery was preferred over the Non-CPA imagery for:

(a) greater detail for identification of target types,
(b) ease of discernible detail of target types, and
(c) accuracy in determination of the number of targets present on a particular scene. In all seven interpretation tasks, targets were more often correctly identified on the CPA imagery.

A failure of the CPA flight testing has been in collecting imagery continuously at normal collection times. If CPA can actually extend the effective film speed of various imagery, then the flight plan must include coverage of the low light level and high shadow conditions on the ground scene.

2.1.8. Mission Summaries

Throughout the duration of the program, all imagery received in the RADC/IRRE Reconnaissance Data Base was given an immediate overall evaluation to determine:

(1) the overall mission quality,

(2) if any sensor malfunction occurred,

(3) if the target area was adequately imaged,

(4) if any film processing problems occurred, and

(5) if the mission objectives were met.

A Mission Summary (Figure 3) was completed on all missions received in the data base, and was included in the appropriate mission data packet.

Sensor malfunctions occurred on less than 5% of all missions flown, while film processing problems were apparent on less than 1% of the collected imagery. Image quality degradation for the most part was caused by improper exposure settings on conventional camera systems.

TABLE 14 RESULTS OF INTERPRETER TESTING

Interpretation Task	Correctly Identified CPA Imagery Preferred	Correctly Identified Non-CPA Imagery Preferred	Incorrectly Identified using CPA Imagery	Incorrectly Identified using Non-CPA Imagery
Greater Detail for Identification of Armor	14	2	--	--
Greater Detail for Identification of Individual Anti Aircraft (AAA)	15	1	--	--
Identification of Fire Control	6	3	5	1
Ease of discernible Detail for Interpretation of Anti Aircraft Artillery (AAA)	10	--	--	--
Greater Detail for Interpretation of Field Artillery	16	--	--	--
Determination of the Type and number of Field Artillery Pieces	15	--	1	--
Identification of Tracked Vehicles to Include dummy tank	14	2	--	--

Figure 3 Mission Summary

PROJECT OFFICER:

MISSION OBJECTIVE(S):

MISSION DATA

PROJECT:	DATE FLOWN:
MISSION #:	SENSOR:
ALTITUDE(S):	SCALE(S):
FILM TYPE:	CAMERA SPEED:
F-STOP:	ASA:
PILOTS:	FILTER(S):
OPERATOR:	AIRCRAFT:
TAKEOFF:	LANDING:
WEATHER:	

MAP DATA

SERIES:

SCALE:

SHEET(S):

EVALUATION

OBJECTIVES COVERED:

GROUND COVERED:

QUALITY:

FILM EXPENDED:

OVERLAP:

SIDELAP:

REMARKS:

2.2. TASK 2 - DATA BASE OPERATIONS

The objective of this effort, as stated in the Research and Technology Work Statement, was to enhance, maintain, and update a multisensor data base for support of research and development programs and to prepare multisensor test photos and other associated photographic products.

To accomplish these objectives, RRC personnel performed three basic functions: (1) data collection, (2) data reduction, and (3) data maintenance. Tasks within the above categories include mission planning, photo lab/processing support, logging, screening, targeting, plotting (to include maintenance of a master cover index), storing and retrieving of data; filling imagery requests and duplicating imagery and collateral data; receiving, logging, storing, retrieving and microfilming documents; ordering and maintaining charts; maintaining security procedures; destroying classified waste materials; and filling various work order requests. Descriptions of major data base tasks undertaken are outlined in the following sub-paragraphs.

2.2.1. Data Collection And Reduction

2.2.1.1. Imagery Collection And Reduction

Various types of multisensor imagery were received in the data base during the course of this 13-month contract. A total of 70 missions was incorporated into the data base storage and retrieval system. Figure 4 depicts the principal data base functions when collecting and reducing multisensor imagery and magnetic tapes.

Mission planning consisted of determining appropriate altitudes for proper ground coverage, and appropriate intervalometer settings to assure adequate overlap for stereo-viewing. In addition, determination of the number of flight lines required, and of the amount of film necessary to complete each data collection mission, was accomplished. The formulas used in mission planning can be found in Figure 5.

Once the imagery was flown, downloaded and processed, it was logged into the data base, and routinely handled as indicated in Figure 4.

One major accomplishment under this contract was the initiation of a Master Cover Index. This Master Cover Index was prepared to enable the data base user to determine if his area of interest (on aerial imagery) is available without researching each individual mission packet. The Master Cover Index depicts area coverage of the data base imagery holdings on 35mm microfilm chips. A description of the mechanics involved in the preparation of the Master Cover Index, and of its value to the data base user, will be provided in Section of this report.

2.2.1.2. Document Collection And Reduction

Currently there are 3,975 technical documents held in the data base pertaining to a wide range of intelligence, reconnaissance and remote sensing

PRINCIPAL DATA BASE FUNCTIONS

IMAGERY	MAGNETIC TAPES
o MISSION PLANNING	LOGGING
o LOGGING	TITLING
o TITLING	STORING
o ANNOTATING	RETRIEVING
o REPRODUCING	
o PLOTTING	
o EVALUATING	
o ANALYZING	
o MISSION SUMMARY PREPARATION	
o PLOT TRANSFER TO MASTER COVER TRACE	
o MASTER COVER TRACE MICROFILMED	
o MASTER COVER TRACE PLACED IN MICROFICHE JACKETS	
o STORING	
o RETRIEVING	

Figure 4

MISSION PLANNING FORMULAS

PARAMETER TO BE FOUND	FORMULA
GROUND COVERAGE (STATUTE MILES) (SINGLE VERTICAL PHOTO)	$G = \frac{H \times P}{5{,}280 \times f}$
NUMBER OF FLIGHT LINES REQUIRED	$n = \frac{W - G}{G(\frac{100-SL}{100})} + 1$
CYCLE RATE (FRAMES/SECOND)/ INTERVALOMETER SETTING	$R = (\frac{.69 \times V \times f}{P_s \times H}) \times (\frac{100}{100-OV})$
	$R \quad 1 \quad = \quad IS$
FILM USAGE RATE (FEET/MILE)	$Fpm = (\frac{f}{H}) \times (\frac{PL}{P_s}) \times (\frac{100}{100-OV}) \times (506.3)$

KEY

G	=	Ground Coverage Per Exposure (Statute Mile)
P_s	=	Film Format Short Side (Inches)
f	=	Focal Length (Inches)
n	=	Number of Flight Lines Required
W	=	Width of Area (Statute Miles)
SL	=	Sidelap Percentage
R	=	Cycle Rate (Frames/Second)
V	=	Aircraft Ground Speed In Knots
H	=	Aircraft Altitude (AGL)
OV	=	Overlap Percentage
IS	=	Intervalometer Setting
Fpm	=	Film Usage Rate (Feet/mile)
PL	=	Film Format Long Side (inches) to include distance between frames

Figure 5

applications. The total number of documents received in the data base throughout the tenure of the contract was 135.

Once documents were logged into the data base storage and retrieval system, they were assigned consecutive numbers and filed in numerical order. Document sign-out cards were prepared for each document received.

2.2.1.3. Support Data Collection And Reduction

Any collateral imagery data, e.g., ground truth information, flight logs for individual missions, charts and maps, were maintained in the data base. The most voluminous category of support data is the map and chart file. During the course of the contract, numerous maps and charts of various scales were ordered from DMA and USGS by data base personnel. The primary purpose of these maps and charts was to provide plotting bases for imagery coverage, and for mission planning purposes.

In addition, charts were ordered to support projects carried on by RADC engineers and their contractors.

2.2.1.4. Data Base Services

Once raw data were refined and incorporated into the storage and retrieval system, data base personnel assisted all data base users in their retrieval of requested information. Written requests that were approved by the appropriate authority have been satisfied throughout the tenure of the contract. The majority of requests were for various types of target scenes on conventional aerial photography, and on infrared and side-looking radar imagery. Over 200 such requests have been filled during the thirteen months of the contract. The following matrix illustrates a variety of tasks undertaken in the RADC/IRRE Reconnaissance Data Base by requesting agencies and projects where available. (See Table 13.)

2.2.1.5. Data Base Enhancement

Data base enhancement includes new or improved procedures for accomplishing data base reduction and services, as well as physical improvements which provide more efficient and economic use of the facility.

The major enhancement programs accomplished under this contract are briefly described in the following sub-paragraphs.

2.2.1.6. Initiation Of A Master Cover Index

A Master Cover Index depicting area coverage of the data base imagery holdings was initiated and prepared throughout the course of the contract. All imagery plot sheets were keyed to the AMS Series and V502 Series 1:250,000 scale charts as a base for the master index. These plot sheets were traced on clear acetate overlay material, and were filmed with a 35mm microfilm camera on a reduction of 21x. Microfilm of the index was input by 1:250,000 area coverage and stored in microfilm jackets alphanumerically.

SUPPORT MATRIX

User/Project	Mission Planning	Imagery Plotting	Imagery Evaluation	Data Base Service	NETA Support	
RADC						
Automated Imagery Pattern Analysis With Stable Distribution (62441067)				X		
Radar Signature Generation And Analysis (62441071)				X		
Radar Target Cueing (62441072)				X		
Image Compression Techniques (62441268)				X		
Digital Exploitation Of Near Real Time FLIR (62440812)				X		
Advanced Digital Exploitation Techniques (ADET) (62441059)			X	X	X	
UPD-X Support (2037000) (20360303) (20370103)		X		X	X	
Digital Cueing For Infrared (62440814)				X		
PTS Support (21060109)				X		
Photogrammetric Support (55690219)	X	X	X			
Reconnaissance Sensor System Exploitation (62441262)	X	X	X	X	X	
Complex Graphics Composer (27160404)				X		
Score (62441038)	X	X	X	X	X	

Table 13

SUPPORT MATRIX (CONTINUED)

User/Project	Mission Planning	Imagery Plotting	Imagery Evaluation	*Data Base Service	NETA Support	
Ground Printer Support (DMA 43020303)				X		
Scat/Star Support (62441256)	X	X		X	X	
QSRS Support (20570101)				X		
ARPA Burma IV Sub Project Risp (181801007)				X		
HQ.SAMSO/RSMG Support (627A000)	X	X	X	X	X	
N.Y. State Agencies				X		
West Point Military Academy	X	X	X	X		
Air Force Interpretation School (Lowry AFB, Colorado)				X		
Washington Agencies Support				X	X	
SAC Training Support Of DMCCCA				X		
Griffiss AFB Support (Base Engineer Base Safety Office)	X	X	X	X		

* Data Base Service includes:

Retrieving Imagery
Retrieving Documents
Retrieving Maps & Charts

Table 13 (Cont'd)

For many years, no master index of image coverage was available in the data base. A number of methods were undertaken to prepare and maintain a master cover index, with little success. Initially, a master cover trace keyed to ONC charts was prepared; however, the bulk involved in storage, and the awkwardness of handling this material, precluded the use of this method. The use of a computer readout was attempted and shelved because input preparation was too time-consuming. RRC personnel developed and initiated a microfilm Master Cover Index that:

(a) Requires little storage space,
(b) Offers easy handling,
(c) Offers easy viewing on the Recordak Magnaprint Reader,
(d) Allows a hard copy record to be made if needed, and
(e) Saves time locating specific area coverage when filling various imagery requests.

All conventional aerial photographic and infrared plots were transferred to the Master Cover Index, microfilmed, placed in microfilm jackets, and stored in a retrievable manner.

2.2.1.7. Initiation Of A Special Reference Index Depicting Available Aerial Photographic and Infrared Coverage Of Military Bases In The United States

Because of the many requests for aerial coverage of military installations in the United States, a special reference index was developed and maintained. Military installations were targetted on each roll of imagery (photo and infrared). Mission numbers were recorded and map tacks with index flags were prepared with the appropriate missions numbers and placed in the target area on a 1:3,500,000 Military Installation chart. Three different-colored tacks and flags were used to delineate the type of military installation, i.e., Army=White Tack/White Flag, Air-Force=Orange Tack/Orange Flag, Navy=Orange Tack/White Flag. "All red tacks/red flags" denotes the availability of thermal infrared coverage.

This index saved many manhours of searching through rolls of imagery to satisfy requests for aerial coverage of specific military installations.

2.2.1.8. Initiation of a Special Reference Index Depicting Available Aerial Photographic Coverage of Major Cities in the United States

A special reference index similar to the one depicting available imagery of military installations was developed and maintained to denote holdings of aerial imagery of major cities in the United States. Major cities were targetted on each roll of imagery (photo only). Mission numbers were recorded and map tacks with index flags identifying the aerial photographic mission numbers were placed in the appropriate geographic location on a 1:2,843,000 United States map.

As with the Military Installation Index, this index saved numerous manhours of searching through rolls of imagery to satisfy requests for aerial coverage of specific major cities.

2.2.1.9. Reduction Of Film Library Holdings

An inventory of roll film holdings at the onset of the contract revealed that much of the film library consisted of duplicate, out-dated, unusable and extraneous film. For two months imagery was viewed to determine its worth. During the following month approximately 20% of the roll film was deleted from the system. This film purge gained space for newly acquired imagery and provided for more economic use of shelf space.

2.2.1.10. Initialization Of A Magnetic/Digital Tape Data Base

Because of the continuous build-up of magnetic/digital tapes, it became necessary to establish a storage and retrieval system for this type of data. Special tape storage racks were assembled in the data base, and several tapes were logged into the system. Sign-out cards were prepared for each tape.

2.2.1.11. Physical Improvement Of The Data Base

At the onset of the contract, the entire 40' x 60' data base was re-arranged to allow cleaner and more efficient storage areas, more secure control over materials being removed from the data base, and more secluded and roomy working space for data base users. In addition, out-dated materials were purged from filing cabinets and map flats, and a more efficient map and mission data filing system was established.

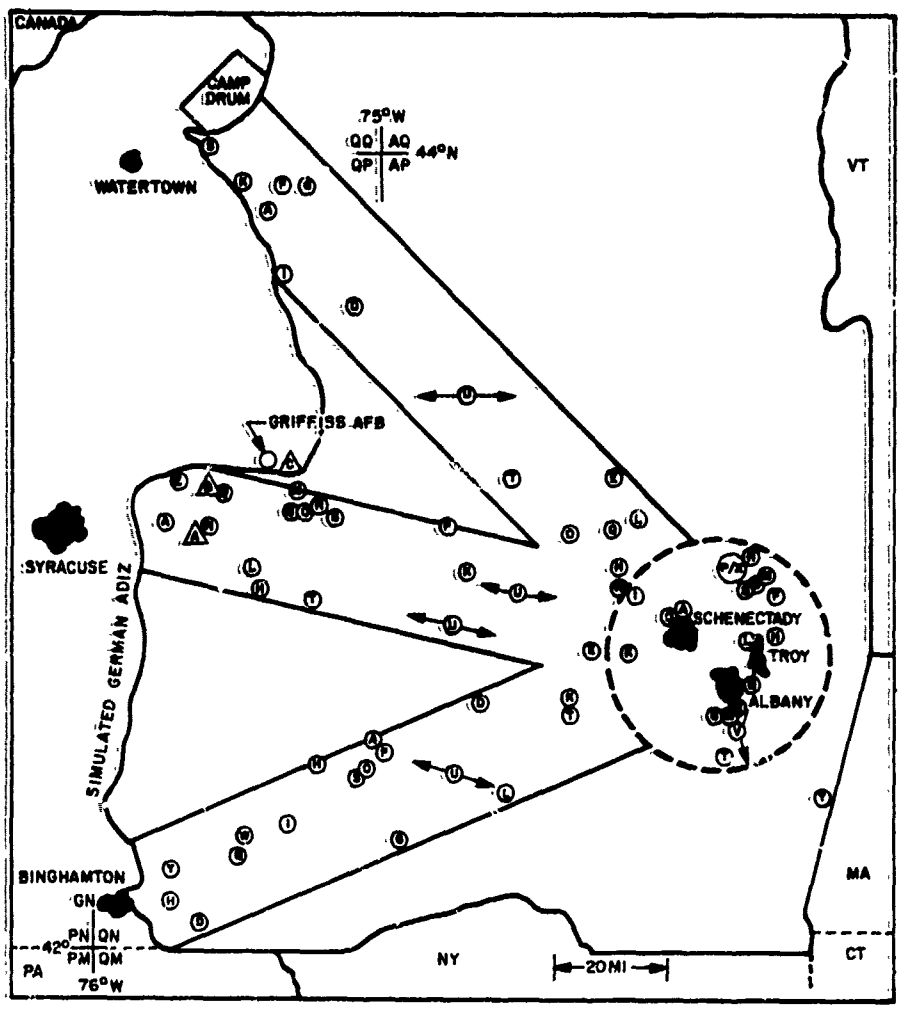
2.3. TASK 3 - NORTHEAST TEST AREA (NETA) SUPPORT

The Northeast Test Area (NETA), developed under contract for the Reconnaissance and Mapping Branch (IRR) of the Rome Air Development Center (RADC), satisfies the long-existing need for a temperate zone sensor test area. Centered in New York State, the NETA facilitates reconnaissance study of industrial and military complexes, communications systems, and topographical features representative of world temperate zones. Features that characterize the Northeastern United States which replicate world temperate zones, and in particular Europe, are:

(a) Topography - river systems, mountains and plains
(b) Climate - continental with maritime influence
(c) Vegetation - agricultural and pastoral lands, softwood and hardwood forests
(d) Target Types - communications, industrial, topographic and military.

2.3.1. Simulated NATO Targets

Approximately seventy-two targets located in three flight corridors and a designated boundary encompassing the Albany, NY area are representative of the twenty-five NATO tactical target categories (see Figure 6). Many of the NATO tactical targets documented for use in NETA reconnaissance evaluations are also usable within a strategic target study. The value of these target



NATO Tactical Target Categories

A – Airfields
B – Bomb Damage Assessment (Conventional) None
C – Bomb Damage Assessment (Nuclear) Available
D – Bridges
E – Coastal Strips
F – Dam/Hydro-Electric Power
G – Electric Power Substations
H – Electronics
I – Ferries and River Crossings
J – Gun Emplacements/Positions
K – Helicopter Landing Areas/Troop and Drop Zones
L – Industries
M – Locks
N – Military/Government Control Centers
O – Military Installations
P – Missiles
Q – POL
R – Ports/Harbours
S – Rail Facilities
T – Road Junctions
U – Route Reconnaissance
V – Shipping
W – Thermal Power Plants
X – Troop/Vehicle Activity
Y – Tunnels

* MEDA A–STOCKBRIDGE B–VERONA C–FLOYD

Figure 6 Location Of NATO Tactical Targets

types is evidenced by the interest expressed by various DOD agencies who are interested in developing automatic classification techniques for refe nce map generation for a family of targets which includes most of those tested below.

(a) Industrial

oil - steel - aluminum - chemical

(b) Transportation

canal locks - highways - bridges - airfields - seaports

(c) Military

arsenals/storage depots - Air Force bases - nuclear sub-bases - air defense sites

(d) Research

missile test sites - nuclear engine and power labs - electronic equipment test areas

Throughout the contract duration, target folders of these 72 targets have been updated with current ground truth data and reconnaissance imagery examples. Detailed information about each target has been collected and placed in each target folder. These folders contain a "Base Pack" and a "Sensor Pack". Included in the "Base Pack" are large-and small-scale annotated maps, photographic and textual ground truth, and large-and small-scale photography including annotated prints and stereograms. In many instances engineering blueprints, sketches and diagrams of the targets are also available. "Sensor Packs" contain photo and infrared and side-looking radar imagery. Assistance was provided to the users of this material throughout the contractual effort.

2.3.2. Military Equipment Display Area (MEDA)

To complement the existing targets, a Military Equipment Display Area (MEDA) was developed. Using the Stockbridge Test Annex to provide a tactical setting, realistic military groups have been deployed. These groups include:

SAM SITE
AAA SITE
SSM SITE
HEAVY ARTILLERY BATTERY
MORTAR BATTERY
ARMORED GROUP (To include dummy tank)
ASSAULT ENGINEER GROUP

GROUND DEFENSIVE POSITIONS
TACTICAL COMMAND POST HEADQUARTERS
MILITARY VEHICLE CONVOY
TACTICAL SUPPLY POINT
V/STOL AIRCRAFT SITE

These groups include demilitarized but functional vehicles, guns, tanks, and personnel carriers which can be maneuvered to simulate the activities of operational tactical units. Figure 7 is a reduction of an engineering drawing of the overall plan of the MEDA.

The principal accomplishments under the NETA task were:

A. Maintenance of all target groups - This includes equipment maintenance, and grooming of ground and earth works to give each target site an occupied look.

B. Updating of Target Folders - As with the NATO targets, a target folder has been prepared on each target family in the MEDA. New information, including aerial and ground photography, was added to the folders as it became available. In addition, new target folders were constructed for the Simulated Frog 7 Missile Site and the V/STOL Aircraft Site. Engineering drawings were prepared (Figures 8 & 9 are reductions of these drawings), and a "Base Pack" and "Sensor Pack" were constructed for each folder.

C. Ground Truth Data Collection - Current ground truth, i.e., weather conditions and ground photography of selected targets, was collected during periods of overflights of the KS-87 CPA and KS-87 Non-CPA systems.

D. Acquisition of New Targets - In preparation for the future UPD-X flight testing over the MEDA, additional targets were procured from the New York and New Jersey National Guard Units at Fort Drum NY. Two salvaged M-84 mortar carriers, and three M-44A 155mm Self-Propelled Guns were acquired for inclusion in the MEDA. Coordination between RADC, New York and New Jersey National Guard units, and "D" Company of the 42nd Maintenance Bn., Utica NY, was accomplished to arrange for movement and demilitarization of these new targets.

2.3.3. Northeast Test Area Application

The NETA and the MEDA provide fully documented targets that will allow for the conduct of a broad range of multiservice, multisensor, and multispectral evaluations for:

- Reconnaissance Cycle and Intelligence extraction.
- Reconnaissance Sensor System Evaluations.
- Human Factors Testing.

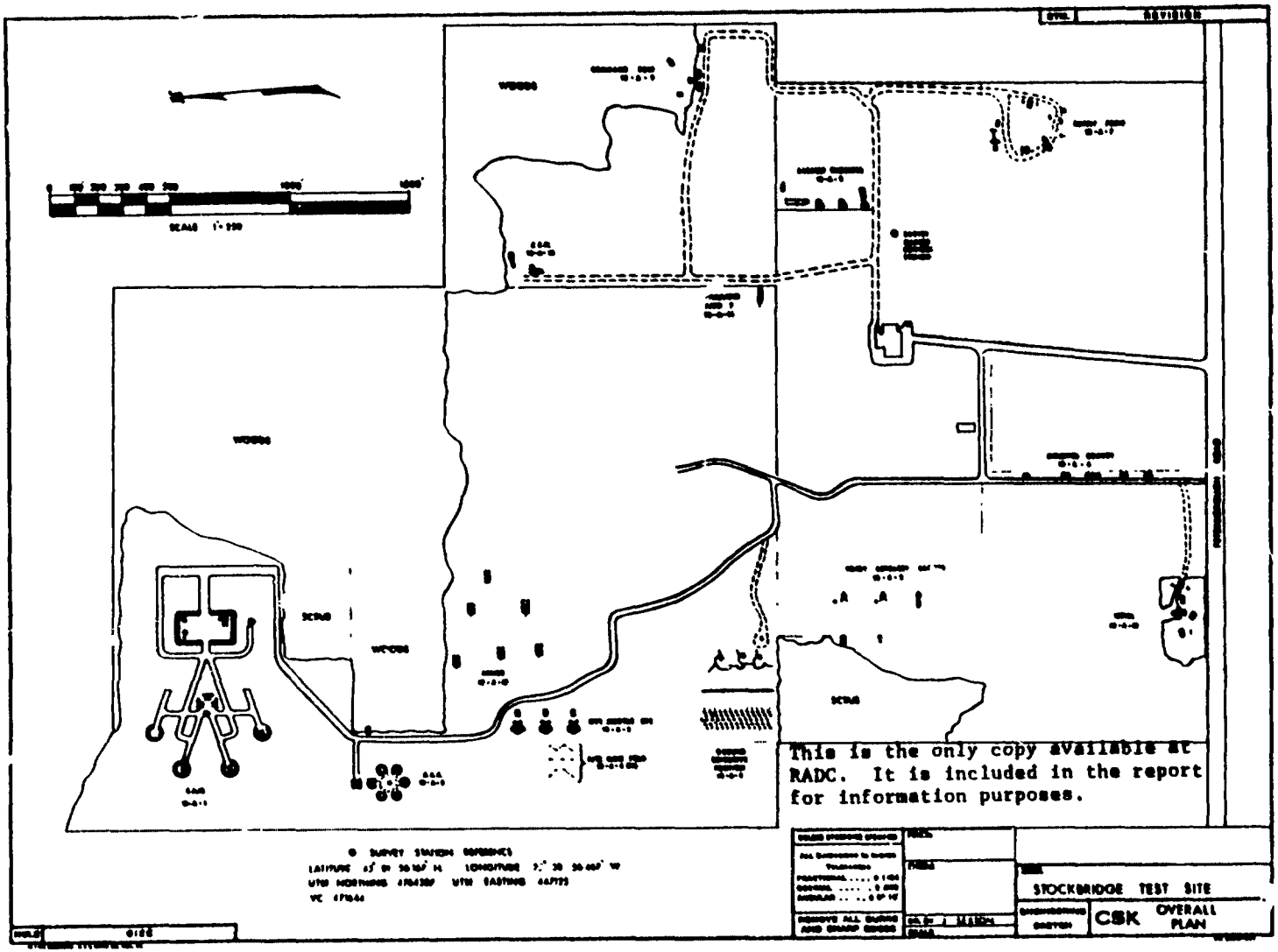


Figure 7 Engineering Drawing of Stockbridge Overall Plan

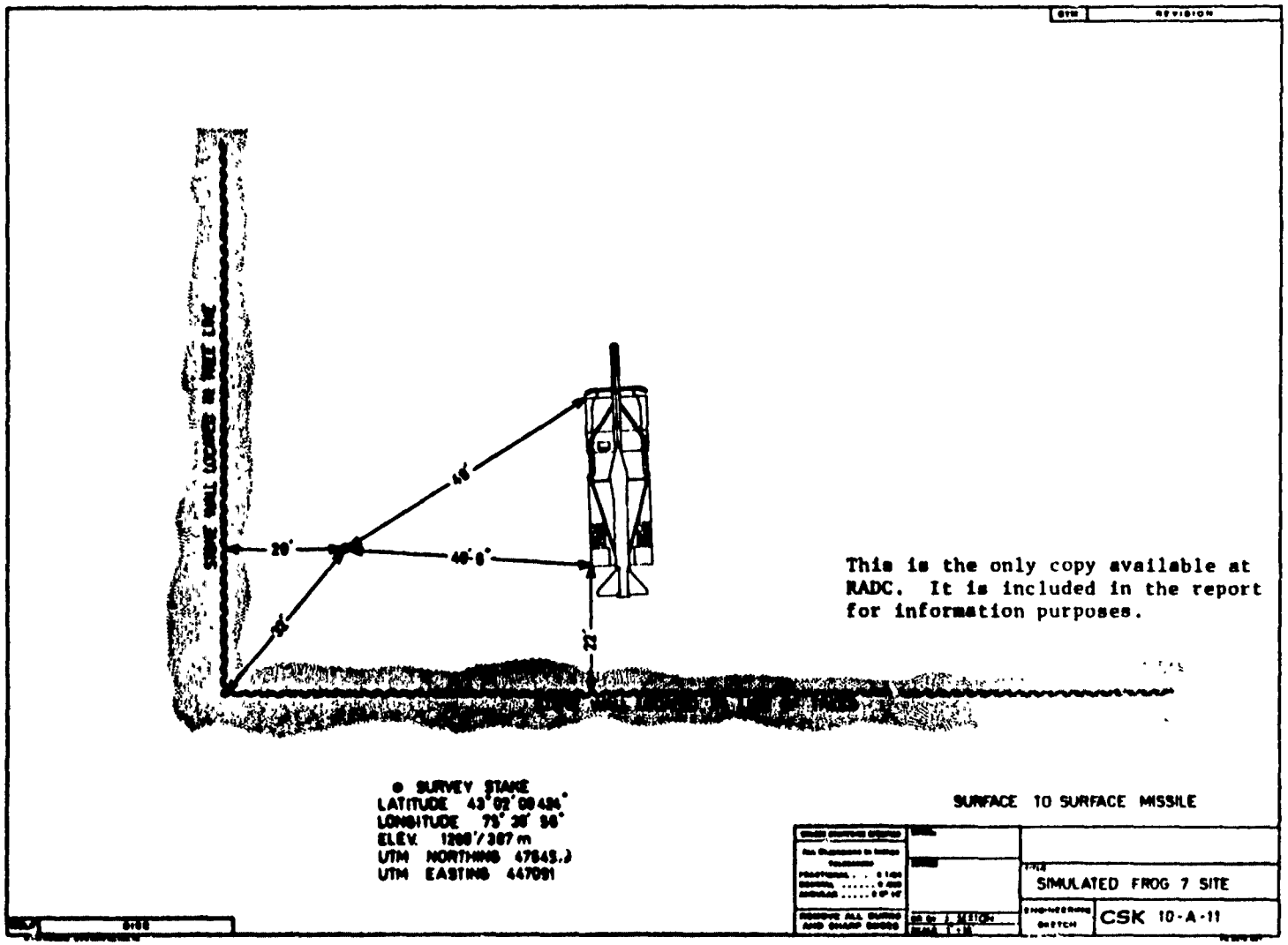


Figure 8 Engineering Drawing of Simulated Frog 7 Missile Site

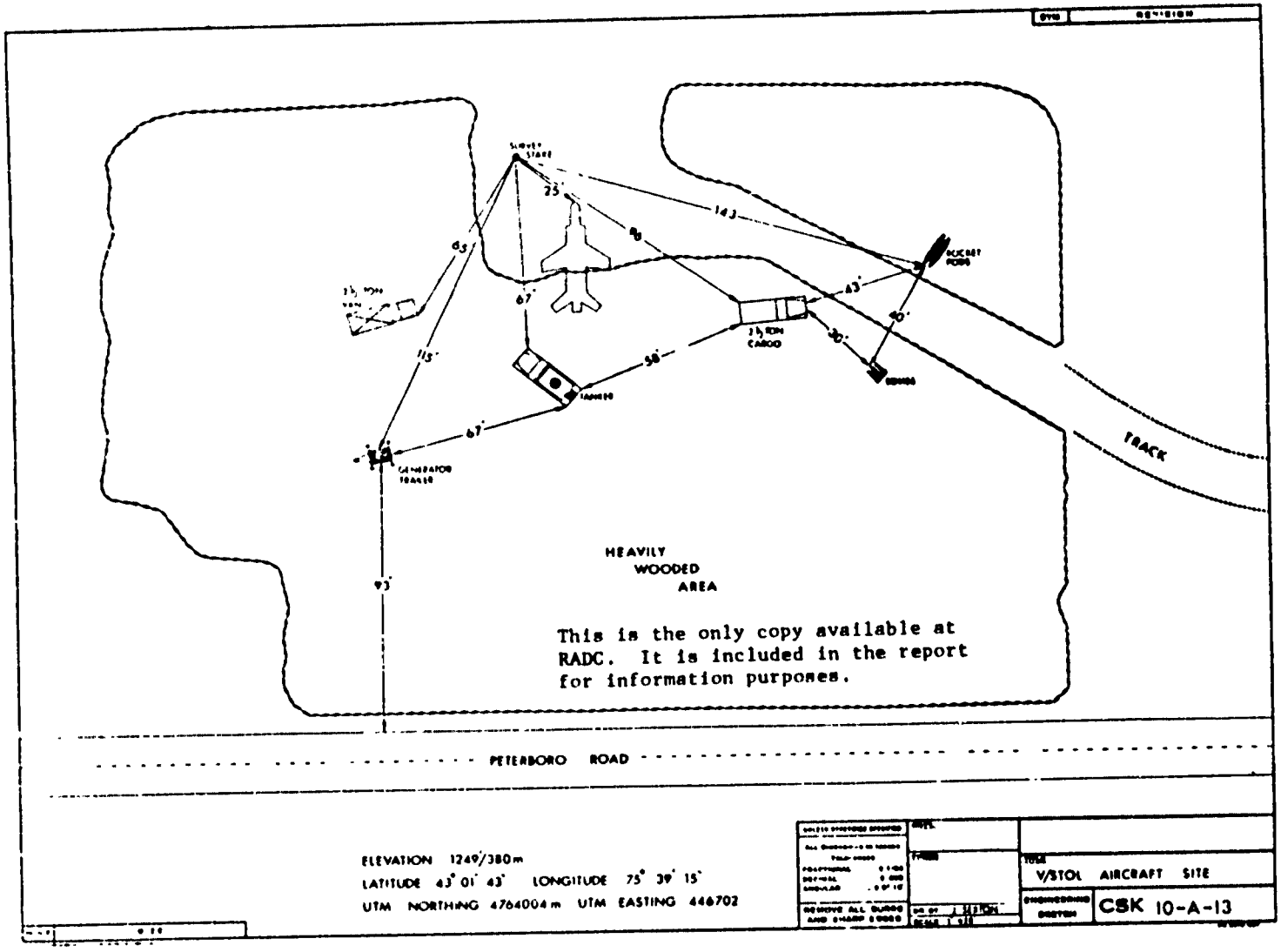


Figure 9 Engineering Drawing of V/STOL Aircraft Site

Other areas in which the Northeast Test Area may be utilized include:

- PTS (Point Transfer System) studies.
- Automated Reference Map Generation experimentation.
- Target Cueing studies.
- Navigation studies.
- Terrain/Target Classification studies.
- Target Signature studies.
- Aircrew Training exercises.

Existing target folders can be tailored to simulate numerous peace/war and tactical/ strategic situation requirements.

SECTION 3

SUMMARY

All of the tasks defined in the contract statement of work have been completed, with the results being described in Section 2 of this report. Contract hours were applied 100% to the effort. Emphasis was placed on those tasks which were assigned the highest priorities by the contract monitor. Rome Research personnel feel confident that the Data Base and the Northeast Test Area (NETA) have become a more valuable asset to the United States Air Force, and to the reconnaissance community in general, through the accomplishments described in this report.

SECTION 4

CONCLUSIONS AND RECOMMENDATIONS

It is the conclusion of the program staff that the services offered under the scope of this contract have been adequately utilized during the past 13 months. Majority of the support provided was in data base services, mission planning, and NETA tasks.

Listed are recommendations for improved and expanded support:

1. All personnel assigned to RADC/IR should be made aware of the services and data available to their programs through the RADC/IRRE Data Base and the Northeast Test Area.

2. Outdated materials should be periodically purged from the data base system and should be implemented with current data.

3. The digital tape library should be expanded to fill the needs of researchers requiring this type of data.

4. A tape directory index should be established to allow the user to become familiar with the information recorded on each individual digital tape.

5. The Imagery Master Cover Indexes should be maintained and upgraded on a regular basis.

6. Data base material and interpretive support should be established, reviewed, and coordinated on a regular basis to assure that these resources are being properly used in support of major IRR programs.

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